Wild Goats of Santa Catalina

by Bruce E. Coblentz

Setting free this herbivore with the "destructive nibble" created a landscape of barren hillsides

Before the advent of refrigeration, nutritional diseases were common among sailors, many of whom lacked fresh fruits, vegetables, and meats during long ocean voyages. In the hope of at least partially overcoming nutritional deficiencies, ships sailing into remote seas often carried cargoes of domestic goats, not only to be eaten as part of a ship's provisions but to be liberated on virtually every oceanic island that was visited. These introductions were for the express purpose of allowing the goats to multiply, thus providing a source of fresh meat for future seafarers.

This concern with fresh meat was the primary reason for the spread of the domestic goat across the oceans. Surely many a malnourished sailor profusely thanked both his Maker and his anonymous seafaring benefactors when, having put in to shore on an uninhabited island, he found an abundance of goats for the taking.

Goat liberations were eminently successful wherever the animals were allowed to range freely and reproduce in the absence of large predators. Although basically a grazing animal of dry uplands, the domestic goat was adaptable to a wide range of climates and vegetation types. As a result of early goat introductions, many oceanic islands—most notably New Zealand, the Hawaiian Islands, the Galápagos Islands, many islands off the Pacific coast of Baja California, and the Channel Islands off the coast of southern California—have high populations of these remarkable animals.

In a few cases the precise history of goat introductions is known. Captain Cook was responsible for introducing goats to New Zealand in 1773 and to Hawaii in 1778, where they were originally cared for royally by the native population.

On other islands, however, the origin of goats is uncertain. Santa Catalina Island (or Catalina Island), in the Channel Islands group, has had goats since at least 1827, when the earliest known mention of them was made. Since they were already established by that date, we can assume that they were introduced well before then. Popular theories about the origin of Catalina Island's goats attribute their introduction either to early Spanish explorers, such as Juan Cabrillo and Sebastian Vizcaíno, or English pirates who later used Catalina Island as a base from which to carry out raids against the Spaniards.

More recently, another aspect of the introduction of goats to the Channel Islands has come to the fore, and its importance does not lie in who liberated the goats, but in why they were liberated. In the early nineteenth century, conditions on board ships were so poor, as was treatment of the sailors, that a ship stood to lose part of its crew if it approached a mainland port. Thus, the thinking is that the goats were liberated on these islands

Traveling in customary single file, a bachelor herd of feral goats heads for a nightly bedding ground within its home range on Santa Catalina Island.

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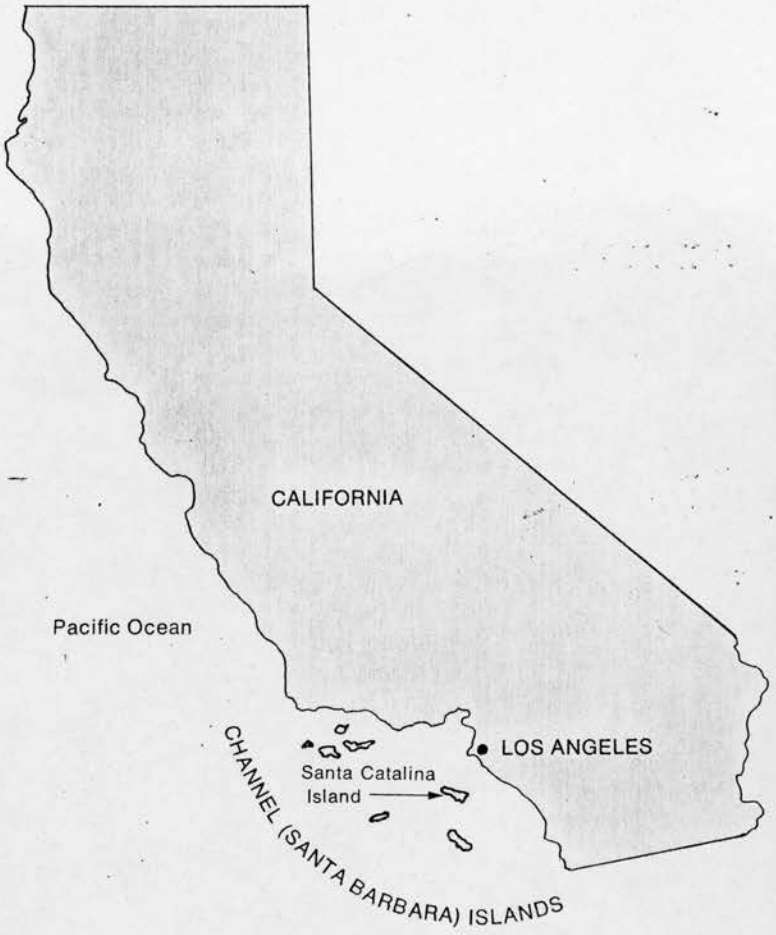

One-week-old kids in a nursery herd peer over a ridgetop. The nutritional status of adult males seems to control the onset of four annual breeding periods.

so that ships could take on a supply of meat without having to put into a mainland harbor.

At present, however, the need to remove or control goats takes priority over speculation on their origins. On most islands the goat population has already caused serious damage to native plant and animal life.

For a 22-month period from July 1971 to May 1973, I studied feral goats on Catalina Island with a twofold purpose: to learn more of their social behavior and to study their ecological effects upon the island. Catalina Island lies about twenty-five miles offshore from Los Angeles. In spite of its proximity to this densely populated area of the West Coast, the island has only about 2,000 year-round residents, and the overwhelming majority of these live within about one square mile in the town of Avalon. Most of the island's remaining seventy-four square miles consists of undeveloped brushy ridges and canyons with a few small grassland areas in the interior. The rugged topography and semiarid climate make Catalina an ideal habitat for goats.

I soon found Catalina Island goats existed in discrete herds, or populations, with nonoverlapping home ranges of one to two square miles. These home ranges were usually bounded by a zone perhaps fifty yards wide on a ridgetop or canyon bottom. Fences became abrupt boundaries, as did paved roads.

The nearly 200 goats in the study area were readily distinguishable by natural variations in coat color and pattern, age, sex, and horn shape. These individual goats had a high degree of fidelity to their own herd home range. The rare observations of goats outside of their home range were almost always of males of adjacent herds during the short breeding periods.

As expected, I found Catalina goats breed like other members of the Caprinae, a subfamily that includes all of the goats and sheep, the chamois, and serows. Large, dominant breeding males guard single estrous females from less dominant males. Once a male successfully breeds a female, he then guards her from other males for a short period after copulation, presumably to insure fertilization by his sperm; then begins seeking other receptive females. As a general rule, females only accept one male, but males breed as many females as they are able. Although this is a polygynous breeding system, serial monogamy is probably a more descriptive term.

Unexpectedly, each discrete goat population on Catalina has four rather regularly spaced breeding periods per year, which I have termed a quadrimodal breeding system. This system, apparently unique among ungulates, appears to be controlled by the nutritional status of the males. After mating with numerous females, the energy level of the male is relatively depleted. A period of feeding is necessary before his physical condition peaks again, enabling him to resume breeding.

Males seem to be able to induce synchronous estrus among any females in the population that are in sufficiently good health to be in reproductive condition. The males do this by producing pheromones, chemical secretions that produce a response in other individuals. These pheromones are presumably released through the males' urine. By directing this pheromone-containing urine into the long hair of the anterior half of their bodies, the males, in effect, become billboards of reproductive inducement. Dominant males exhibit greatly increased frequency of this urine-marking when they are in peak physical condition, the point at which they have a better chance to breed a maximum number of females. Fe-

Overbrowsing by goats has caused severe ecological damage. A fence erected to exclude goats from the central portion of the island has enabled plant life to regenerate.

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imals that require dense ground cover or abundant ground level food—such as small terrestrial rodents, reptiles, and ground-nesting or ground-feeding birds—may be excluded rather quickly. The over-all effect of plant overutilization, erosion, and compaction also contributes to increased mortality of trees and to the reduction of forested areas. This, in turn, tends to eliminate any animal species dependent upon the forest habitat. As time goes on, the goats create a habitat that is exceedingly inhospitable for most other animal species.

In less than 200 years in Hawaii, the goats have been described as having "chewed their way from the seashore to the tops of island peaks and back down again." On Catalina Island, goats have not only worked their way from the seashore to the mountain peaks and back down again, but some herds travel from the peaks to the shore on an almost daily basis. In their daily travels they make use of any suitable terrestrial vegetation encountered, and on occasion they graze on kelp and other marine algae found in the intertidal zone.

This "destructive nibble" of the goat is also directed at forage of poorer quality than that utilized by almost any other herbivore. Bitter, oily plants may be taken, almost exclusively, by goats. The problem is that goats, like any other herbivore, will take all of the higher quality food first and only then turn to the lower quality food. Before the forage in an area is all of poor quality, the goats will have removed the forage of sufficiently high quality to sustain other herbivores. This usually insures that the goats will be the only large herbivores in an area where they are allowed to increase unchecked for extended periods.

On Catalina, mule deer were excluded from areas of high goat density owing to the lack of food. Deer were regularly seen in adjacent goat-free areas, but not in the goat ranges themselves. Feral pigs were found in both goat and goat-free areas; however, the pigs in goat areas were generally smaller and appeared to be in much poorer health than those found elsewhere on the island. Likewise, litter sizes of pigs were smaller in the goat areas. One reason for their ability to live in the goat areas was that the pigs physically outcompete the goats for certain seasonally limited, high-quality food sources such as acorns and other fruits.

The effects that the goats have had upon certain passerine birds on Catalina is not certain, but on Guadalupe Island to the south, they have definitely brought about the elimination of at least three species. On Catalina, the endemic subspecies of California quail, a ground-nesting and ground-feeding species, is obviously less abundant in, or absent from, areas of high goat density, as are three of the five endemic terrestrial mammals: the island gray fox, the deer mouse, and the western harvest mouse. Only the ground squirrel seems to do well in goat-disturbed areas. (The status of the fifth endemic species, the Catalina shrew, is unknown.)

Not only do goats denude the areas in which they live, but because of their tendency to travel between areas in single file, they establish many distinct goat trails throughout their home range. This concentrated trampling, and resultant soil compaction, removes a considerable amount of goat habitat from production and thereby reduces the over-all productivity of the area. In most areas where goats have become established, they travel along distinct, well-worn, and often traditional trails. The constant use of these trails has made the surfaces nearly as hard as concrete. On frequently used trails nothing grows at all, while on occasionally used trails the little that does manage to begin growing is soon trampled and killed, if not eaten first.

On a single hillside there can be many trails, although one or two always stand out as those most frequently used. The combined area of all the trails on a hillside can be considerable, perhaps as much as 2 to 3 percent of the area. Goat trails generally follow the easiest route between two points and generally parallel a hillside, although in a few places trails do run in a more uphill–downhill direction. In many such places the trails have initiated significant gully formation.

By causing severe erosion and runoff in an island situation, goats may also adversely affect the littoral marine environment. In the absence of plant cover, soil is rapidly washed down to the ocean where it can settle out and perhaps choke the sessile filter-feeding organisms that are present. After winter rains, ocean areas near certain canyon mouths on Catalina have been observed to be stained brown from the soil washed from the land. The amount of particulate matter in the runoff of these canyons appears to vary directly with the populations of goats in the particular canyon drainages.

The goat is perfectly designed for utilizing the quantity and quality of vegetation that it does. Like most ungulates, goats are ruminants, meaning that they have a four-chambered stomach, the forechamber being the rumen. The rumen is greatly enlarged and acts to facilitate bacterial and protozoan fermentation. Lacking the enzymes required to break down cellulose and other relatively impervious, energy-containing carbohydrates, the ruminants depend upon the vast numbers of bacteria and protozoans in the rumen to break down these compounds for them. These microorganisms digest much of the plant material that the animal eats and produce volatile fatty acids as a by-product of fermentation. The metabolites that result from the microorganisms' digestion of plant material are absorbed directly from the rumen and provide energy, as do sugars in simple-stomached (monogastric) animals. The microorganisms themselves are then digested as they pass into the animal's intestine.

The advantage of the rumen lies in the fact that foods of relatively low quality can be ingested and utilized by the ruminant, whereas the same foods might result in starvation for monogastric animals. There is an inverse relationship between the relative size of a species' rumen and the diet quality that the species requires for maintenance. In general, the narrower the ratio of rumen volume to total body volume, the coarser (less protein, lower digestibility) the diet that the species can live on. All members of the Caprinae have a narrow ratio, but that of the domestic goat is especially narrow due to its relatively immense rumen. Because of this digestive anatomy, the goat can live on forage of insufficient quality to sustain other herbivores. Almost as important is the goat's extremely high

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threshold for bitter and oily plants, which most other herbivores will avoid.

Owing to the goat's unique combination of abilities to utilize food, there is essentially no plant species that is 100 percent safe from utilization. No plant species—not even tree tobacco, prickly-pear cactus, and the poisonous locoweed, which were found growing in the goat areas of Catalina Island—was completely free from utilization.

In addition to this digestive capability, the goat is behaviorally adapted to procure food in situations that would thwart all but the most highly specialized herbivores. The goat is exceedingly surefooted; it can reach vegetation growing on nearly vertical cliffs and canyon walls and climb trees whenever there are low horizontal limbs or inclined trunks. On Catalina, it was not unusual to see goats moving from limb to limb searching for forage in scrub oaks or other trees.

Even in normal, everyday feeding, goats frequently stand upright on their hind legs and use their front legs to push vegetation down. They can literally walk an upright stem down to the ground and eat the foliage off the top while standing on it. When finished, the goat steps sideways and a considerably denuded stem springs back to an upright position.

Goats are also individually adaptable, as evidenced by the varied methods used to render a prickly pear less painful before it is eaten. Some goats simply paw at the spines to break them off, while others break the pad off and then hold it in the mouth while rubbing the spines off on the ground. Some goats butt the cactus to a pulp with their horns and then take bites out of the crushed plant; others take bites out of the undamaged pads. All goats eat prickly pears and, in fact, go to great difficulty to obtain them, probably because these "cactus apples" are particularly palatable. As a general rule, in areas of high goat populations only those plants that are too straight or large to climb, or that grow in the protection of a formidable patch of prickly pear, are completely free from utilization by goats.

The primary problem in controlling feral goat populations is that, in most cases, absolute elimination is the only viable, long-term solution. Based on data collected from feral goat studies in New Zealand, it has been conservatively estimated that if a population of goats is reduced by 80 percent, it can recover to 90 percent of the original number in just four years. This means that if the population to be removed is not completely eliminated, subsequent control will be necessary at frequent intervals. In addition, the New Zealand calculations were based on the assumption of a fixed rate of reproduction. In actuality, we know that reproductive rate increases as population density decreases, so that as goats are removed, the reproductive rate of the remaining goats will increase and the original population level will probably be reached sooner than predicted.

In contrast to the reproductive rate of the New Zealand goats, and the even higher possible rate of increase of domestic goats, Catalina goats have a poor reproductive rate due, basically, to the poor nutritional level of goats in areas of high density. Well-fed domestic goats may give birth to twins or occasionally triplets every eight or nine months. In contrast, Catalina goats average less than one birth per year (actually less than one per 16 months) and only about 1.2 young per birth, considerably less than biologically possible for the species. Interestingly, recent evidence on Catalina indicates that due to a series of excellent growing seasons the rate of reproduction is noticeably increasing.

Although goats are easily found and removed at first, the greatest stumbling block to complete goat removal is that the amount of time and effort required per goat increases greatly as the population density decreases—a sort of diminishing return on effort invested phenomenon.

When a goat control program was instituted on Catalina about fifteen years ago, an attempt was made to totally remove goats from certain geographically defined portions of the island. This objective met with success in a large central portion of the island where there are currently no goats. The numbers of plant species and individuals present and the total production of native vegetation have recovered to a remarkable degree in this goat-free area. In other areas of the island that did not lend themselves to complete elimination as easily, small remnant populations have required frequent follow-up removal operations to allow the vegetation to continue recovering.

The contrast between goat-free areas and areas of high goat density is now considerable in all seasons, in terms of the flora and the fauna present. Not only is the density of vegetation greater in the goat-free areas, but due to increased organic litter buildup and greater moisture retention of the soil, the size and growth rate of individual plants is also much greater. Whereas in the goat area wild oats may reach a height of only a foot before setting seed, in the goat-free area the same species will reach three to four feet. In addition, some species, such as California sagebrush, Saint Catherine's lace, and the perennial bunch grasses that were eliminated or severely depleted in the goat areas long ago, have reestablished themselves in many of the goat-free areas.

Ironically, the goat has become an ecological liability because of the very qualities that made it an asset and a friend of man for the past several thousand years. The utility of the goat has been threefold: (1) Its fairly small size and low enough value have allowed it to be owned even by poor people. (2) It can survive on forage of extremely poor quality, such as that found in harsh arid environments or in other areas during severe drought. (3) It has a potentially high rate of reproduction. Perhaps even more importantly, the goat has proved adaptable enough to survive and reproduce in the humid tropics, a feat that few temperate zone ungulates could accomplish.

Obviously, an animal adapted to survive in such a wide range of environmental conditions, and whose adaptability has been rewarded through selection of the best-adapted individuals, could be expected to overtax virtually any environment into which it was liberated with no constraints placed upon it other than food limitation. In the past several thousand years man has been creating and perfecting this ecological monster; now man must impose controls where natural means have failed. □

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